

Zigler & Barrett.

Further contribution to the tactual
perception of form.

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Z64
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Copy OneJournal of Experimental Psych.
April, 1927.A FURTHER CONTRIBUTION TO THE TACTUAL
PERCEPTION OF FORM

BY M. J. ZIGLER AND REBECCA BARRETT

Wellesley College

This investigation was undertaken with the twofold purpose of dealing more fully with certain aspects of a study recently reported¹ and of extending our investigations to certain new conditions of the tactual perception of form. Our experimental work presented three principal problems. (1) To determine the influence of completeness and incompleteness of contour as distinct from total areal impression upon the perception, we used, in addition to the solid stimuli of the previous work, figures which were partially or completely outlined. (2) As regards the place of excitation, we stimulated on the palm of the hand, on the ball of the thumb, and on the volar surface of the forearm, in order to determine the influence of differences of sensitivity upon the apprehension of form. And (3), with respect to central processes, we hoped to come to closer terms with the problem—already suggested and somewhat inconclusively dealt with in the reference given—of the immediacy or mediacy of this perception. If mediate types appeared, we proposed to note observable stages in the development of the perception.

THE EXPERIMENTS

The experimental conditions were practically the same as in the previous work. O was seated in a comfortable chair at the side of a low table. The bared right arm was extended, volar side upward, over the edge of the table, which was padded for comfort. The parts stimulated were at all times concealed from O by a cardboard screen. Through a small

¹ M. J. Zigler & K. M. Northup, The tactual perception of form, *Amer. J. Psychol.*, 1926, 37, 391-397.

SUMMARY

The results here reported in general verify and amplify our preliminary findings. The most outstanding facts may be summarized in the following statements.

1. The reading of Chinese differs from that of English chiefly in the spatial distribution of the pauses. The square shape of the Chinese words and their more compact arrangement in a line demand eye-movements of smaller angles and a decidedly greater number of pauses per line than in reading English.

2. The inter-fixation span varies from half-a-word to six words. The average is two words. The duration of a fixation varies about an average of roughly .3 second.

3. The first line of a passage is usually read with a greater number of pauses than on the average. The first pause in a line, unless immediately followed by a regressive movement, has a longer duration than the average. The last pause in a line generally deviates inward from the last word, and it is somewhat shorter in duration than the average.

4. The pause-duration in horizontal reading is shorter than in vertical reading. But this difference is more than counter-balanced by the longer inter-fixation span in vertical reading. Comparable passages are thus read faster in vertical than in horizontal alignment.

5. Characteristic differences between vertical and horizontal reading suggest certain physiological differences in the mechanism of eye-movement. In vertical movement, the center of rotation of the eye ball is shifted forward, and there is also a temporal disparity between the actions of the superior rectus and inferior oblique muscles. There is a tendency of the eye in vertical reading to make gliding movements and unsteady fixations as opposed to a clear-cut distinction between jerks and pauses.

notch in the bottom of the screen the hand of O was placed in position.

The stimulus-figures were cut from hard-rubber stock of 5 mm thickness. We used the same five figures as before; square, equilateral triangle, right-angle triangle, diamond and hexagon. There were three sets of each figure; one *solid* (as in the previous work), one *outlined* (the central parts chiselled out to leave a narrow rim 2 mm wide along the edge), and one *partially outlined* or *pointed*. The last were constructed by mounting small rounded points of 2 mm elevation at the juncture of adjacent sides of the figure. There were three points for the triangles, four for the square and the diamond, and six for the hexagon. Five sizes were provided for every one of the figures in each of the three sets. The main dimensions (as given also in the previous paper) were 12, 14, 16, 18 and 20 mm. We had found that these dimensions range from the lower limit of clear perception of form to the region of optimal size for perception (p. 396).

The stimuli were applied with the previously described (p. 391) mechanical applicator, which enabled us to apply all figures at roughly the same intensity of pressure, about 500 gr.

The figures of all three sets were thrown together and arranged in haphazard order. The stimuli were always applied to the same area and always in the same position. Thus in stimulation of the arm the apex of the triangle was always toward the wrist, and the parallel sides of the square and the hexagon and the longer axis of the diamond were always applied in the longitudinal direction of the arm. The same mode of application was used on the palm and the thumb. We worked on the volar forearm midway between the wrist and the elbow, at the juncture of the first and second metacarpals, and on the central part of the ball of the thumb. A temporal interval of at least 20 sec separated all presentations; and longer resting periods were regularly given after 10 or 20 trials. From 50 to 75 presentations were made at a sitting.

One of us (Barrett) served as experimenter. The four O's

were Zigler (Z), a member of the staff; K. Ward (W), a senior 'major' in psychology; and M. Davidson (D) and A. B. Hoffman (H), graduate students. W and Z were O's in the previous work; but the others were untrained in tactual observation. The general instruction read as follows:

After the ready signal, a tactual stimulus will be applied to the volar surface of the forearm (palm, or ball of thumb). You are to observe carefully and report the shape of the tactual impression and all observable criteria upon which your perception is based. If you prefer, you may sketch the shape of the impression on paper.

RESULTS

i. *Adequacy of perception.*—As in the previous study, the triangles were correctly perceived much more frequently than the other figures. They totalled more than two thirds of all the correct judgments from all three regions. The square was correctly judged more frequently than the diamond by all O's except Z, who found the diamond much easier. This is probably due in part to the fact that the square is a more common figure than the diamond; so that the O's working without knowledge more readily apprehended the square, while the O working with partial knowledge had no central disposition favoring any one of the five figures. Z reported that the diamond, as a rule, was more clearly given than the square; and other O's, in the few instances when the diamond was correctly perceived, testified that the impressions were extremely clear and definite. The tendency to perceive the diamond as a triangle was very pronounced in the case of every O, and is probably the chief explanation of the fewness of correct 'diamond' judgments. The reverse tendency of perceiving the triangle as a diamond was negligible. As in the earlier study, the hexagon was rarely reported. Z recognized it several times in all three of the regions stimulated; but of the O's working wholly without knowledge, it was recognized only by W who reported it 5 times upon the thumb. This figure usually gave a very indefinite, unclear and blurry outline; and the shape most frequently assigned by the O's (other than Z) was the circle. Even Z repeatedly testified that this figure aroused the impression of a disc-like form. It is evident that the figures whose sides form acute

angles give more definite tactual clues to physical character than do those whose sides form right or obtuse angles. This is probably due to the fact that the *pressure gradient* of acute angles is steeper than that of right or obtuse angles. The tabular results here are wholly similar to those of the previous work.

ii. *Positiveness or definiteness of perception*.—For the purpose of determining more precisely the influence of angle on the definiteness of perception, we next added to the instructions the demand that the degree of ‘positiveness, definiteness or clearness’ of form be designated in all observations and in as many degrees as the O’s could easily discriminate. After a sitting or two they were inclined to indicate four degrees; very positive assurance, fairly positive assurance (mild uncertainty), uncertainty (very little subjective assurance), and great indefiniteness (no notion of shape).

Between 65 and 85 per cent. of all the ‘very positive’ judgments fall under the two triangles. For two O’s the equilateral had a slightly higher percentage than the right angle; for a third, there is no difference; while the fourth O gave a somewhat higher percentage with the rectangular form. Erroneous judgments were fairly rare with the two higher degrees of assurance. With regard to the three other forms, there is little consistency among the O’s, except that the hexagon is mentioned only four times.

The most significant fact regarding the three tactual areas is that ‘positive’ perceptions are very much rarer than uncertain, in all regions. We give here a tabular presentation of these orders of positiveness (from *a*, maximal, to *d*,

Obs.	Arm			Hand			Thumb		
	<i>a</i>	<i>b</i>	<i>c & d</i>	<i>a</i>	<i>b</i>	<i>c & d</i>	<i>a</i>	<i>b</i>	<i>c & d</i>
Z.....	3	5	92	5	7	88	8	11	81
W.....	2	8	90	2	12	86	4	15	81
D.....	0	4	96	0	7	93	2	7	91
H.....	0	0	100	0	5	95	0	9	91
Totals.....	5	17	378	7	31	362	14	42	344

minimal). A sharp distinction between *c* and *d* was at times hard to draw. As it seems to have small validity, the two degrees are thrown together.

The table reveals several definite tendencies. (1) Less than 1/5 of all the perceptions stand under the first two degrees of assurance. (2) The percentages for *a* are smaller than for *b*. (3) The totals for assurance are highest in the thumb region. D and H seldom report high assurance, and their correct judgments are much lower than the other two.

For the purpose of ascertaining whether differences in sensitivity influence the accuracy of perception, the figures were again presented to the three regions in a new series, the O's observing under the same general instructions as before. The percentages of correct judgments, followed by the total trials (in parenthesis), are as follows.

Obs.	Total No. Trials	Arm	Hand	Thumb
Z.....	1119	18 (271)	39 (500)	60 (348)
W.....	1194	9 (271)	22 (575)	44 (348)
D.....	890	4 (271)	5 (500)	23 (119)
H.....	1060	3 (271)	5 (500)	13 (289)

Again the thumb gives maximal adequacy as well as maximal assurance and definiteness. The experiences in which form was poorly perceived were sometimes characterized as 'dull' and of a dispersive nature; while the pressure of a definitely given form was indicated as 'sharper' or 'less blunt' than that of a form indefinitely perceived.

iii. *Influence of type of figure upon perception.*—The numerical results for our three types are as follows. They give, in percentages, the number of correct perceptions reported.

It appears that the outlined figures are slightly more easily apprehended in all regions than either of the other types. The single exception is D (arm) where the percentages for outlined and solid figures are the same. The reports indicate that in the clearest perceptions mediated by outlined figures the attention is directed solely to the contour of the

	Obs.	Total Correct Perceptions	Solid	Outlined	Point
Arm.....	Z	50	38	46	16
	W	26	38	42	20
	D	8	37	37	26
	H	13	31	62	7
Hand.....	Z	97	30	40	30
	W	81	38	40	22
	D	16	19	44	37
	H	16	37	44	19
Thumb.....	Z	211	32	38	30
	W	156	34	36	30
	D	55	38	60	2
	H	16	32	50	18

pattern; whereas with solid figures there is a central area of pressure which claims attention as well as the contour parts. These more central parts often cloud and obscure the total perception so that the form is not clear. The point figures secure something less than half the percentage of correct judgments of the outlined figures; but they stand considerably nearer the solids in effectiveness for perception, thus showing the importance of the turning points of contour or outline.

iv. *Tactual tied-images*.—With the point figures, the O's were frequently unaware of the punctal character of the isolated or discrete pressures. Instead they reported completely outlined shapes. The isolated points seemed to condition a tactual tied-image² or filled-in perception.³ The corners were described as clearer, more intense, more definite and bolder than the sides; yet there was at no time a suggestion that these components of the experience were of a substantially different character. It appears that, as in the case of visual⁴ and auditory⁵ tied-images, the tactual tied-image is of the same qualitative nature as the corresponding sensory experience. In many instances, especially on the

² Cf. E. B. Titchener, *A beginner's psychology*, 1915, 75.

³ Cf. H. C. Warren, *Human psychology*, 1920, 262 f.

⁴ M. J. Zigler, An experimental study of visual form, *Amer. J. Psychol.*, 1920, 31, 273 ff.

⁵ F. L. Dimmick, An experimental study of auditory tied-images, *ibid.*, 1923, 34, 85-89.

thumb, where the two-point threshold is low, the separation of isolated points was noted; and in such cases the tied-image failed to connect the discrete sensory elements. The perception of shape was not, however, rendered impossible here. Visual imagery played a prominent rôle. Tactual completion was more characteristic with the smaller figures in the regions of higher threshold; although visualization played an accessory part in these cases. There were occasional undeveloped or incompleted tendencies to tactual completion (*e.g.*, of one side, or a part of one side, of a form) even in the larger figures; but visual imagery was more characteristically resorted to as the mode of completion of the larger forms.⁶

v. *The temporal course of the perception.*—Two of our O's made the comment that the forms were at times not immediately perceived; that there was an observable temporal disjunction between an initial phase and the mature perception. Accordingly, as the final step of our experimentation, we presented the figures on the thumb with the following sentence added to the general instructions; "Report especially upon the temporal course of the experience." H failed in two sittings to indicate temporal stages; but the other O's succeeded in most trials. The three stages delineated were: (1) an initial or preliminary stage in which O realized a touch of indeterminate shape frequently ill-localized and generally labelled a "pressure blur"; (2) an intermediate stage in which a prominent feature of the boundary of the form caught the attention and sometimes suggested a tentative but unsatisfactory shape, and (3) the final stage, in which the form was definitely perceived with more or less clarity. Frequently these stages were partially telescoped. Thus, stages 1 and 2 were sometimes indiscriminable, the prominent feature of stage 2 catching the attention at the moment of stimulation. At other times, stages 2 and 3 were telescoped so that there was an immediate shift from the unoutlined pressure of stage 1 to the fully developed perception of stage 3. Again,

⁶ Our method of arousing pressure imagery (in the 'tied' form) is superior to methods recently described by Braddock (An experimental study of cutaneous imagery, *ibid.*, 1921, 32, 415-420). Neither of her O's realize, with positive assurance, the existence of true cutaneous imagery.

the three stages were at times so completely telescoped that the transition from stage 1 to stage 3 was imperceptible. The more characteristic occurrence was a suspended or immature perception, in which case the perception did not develop beyond stage 2 and remained unclear and indefinite, because only one or two pressure highlands forming a part of the contour were clearly perceived.

The following reports are representative of the most clearly indicated stages:

"In the first instant there was only a pressure of indeterminate shape. I knew that I had been touched; but the pressure lacked form and was indefinitely localized. It was only a fraction of a second, it seemed, when I noticed two angles quite clearly and at a considerable separation, and a moment later I observed the outline of the wider and intermediate part of the area and perceived a clear diamond form" (Z). "There was a large indefinite area of pressure, then quickly I perceived two parallel sides, and then the completely outlined square, which was more positively given this time than usual" (Z). "At first I felt an indefinite point, then I perceived the two points, which represented the extremes of the figure, and, as I visualized, passing from point to point, the form of the triangle appeared very clearly" (W). "First I felt an indefinite line, then two sides were perceived; but they gave no notion of shape until an instant later when a definite triangle was perceived" (W). "A vague pressure area or field, then three corners appeared to give it the outline of a boundary, and in the next moment I visualized a triangle" (D). "A pressure lacking definiteness, then a corner caught the attention, and by the aid of visualization I got the relationship of the several other corners which followed the first one and reported 'square'" (D).

These stages follow one another with extreme rapidity, so that in many instances they are barely observable and the various components of the perception are constantly changing until the final stage is apprehended. Yet the stages are distinctive enough in most instances to justify the claim that tactual perceptions of form are not, as a rule, immediate; and that we have been able to push behind the perceptual pattern to a sensory matrix, which is pre-perceptive, indefinite, at times ill-localized, and which represents the nuclear part of the experience around which the perception of form subsequently develops. From this initial stage the perception develops, first by acquiring certain salient features of the contour of the figure, and, finally (where the perception fully matures), by the apprehension of a definite and complete form. We have also indicated the pronounced, ingrained disposition to grasp in fleeting succession any topographical

highlands in terms of which the experience may assume shape once the sensory matrix, around which a form may be organized, has been created.

SUMMARY

1. The forms of outlined figures are slightly more clearly perceived than those of solid figures; the forms of point figures (only corners designated) are less clearly perceived than those of solids.

2. The perceptual form of point figures is, in many cases, completed by tactual tied-imagery, which bears very close psychological resemblance to the corresponding sensory experience; in other cases, the completion is in terms of visual imagery.

3. The perception of these figures is more adequate at the thumb than upon the palm of the hand or on the forearm. The arm is decidedly inferior to the hand.

4. Figures having acute angles are correctly perceived much more frequently than are those having obtuse or right angles, owing, probably, to a steeper pressure gradient.

5. The positive perception of form, with high assurance as to the particular shape, is relatively infrequent under our conditions; more infrequent from the hand or arm than from the thumb.

6. When the perception rises gradually, the following stages may be distinguished: (a) a preliminary stage of shapeless pressure or pressure blur in which the experience is unclear and indefinite as to outline and frequently ill-localized; (b) an intermediate stage in which one or two salient features of the form acquire definiteness and clearness and (c) the final stage in which the outline is clearly and completely given. These stages may be partially or completely telescoped, may overlap one another, or may so suffer arrest as to suspend perception at a point of immaturity and incompleteness.

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